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Evaluating the Effects of Super Absorbent Polymers (SAPs) on Growth of Eggplant

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Abstract: ***Super Absorbent Polymers (SAPs) have been used as water retaining materials in agricultural fields. They can release stored water slowly as required by the plants. The aim of the present study was to evaluate the effects of a constant weight of SAPs (3g/l.5kg of growth media) which were prepared by radiation-induced crosslinking of different percentage (30%, 40%, 50%) of acrylic acid onto coir dust using different dose (10-30kGy) of gamma radiation. Fifteen samples and sixteen pots were arranged on growth of eggplant in prepared soil media. In experiment involved, the same soil (1.5kg) media mixture was used 3g of super absorbent. For the first two weeks the plants were given an enough amount of water, then watering interval was reduced to 3days a time in each pots. The analysis of data indicated that the effect of SAP on plant growth parameters such as plant height, number of fruits per plant, and yield had significance. The results indicated that the sample with acrylic acid 50% and 20kGy produced a high yield.***

Keywords: Super Absorbent Polymer, Eggplant, Water retaining, Growth parameter

1. Introduction

Super Absorbent Polymers (SAPs) are compounds that absorb water and swell into many times than their original size and weight. They are lightly cross-linked networks of hydrophilic polymer chains. The network can swell in water and hold a large amount of water, while maintaining physical dimension structure. It was known that commercially used water absorbent polymeric materials employed are partial neutralization products of cross linked polyacrylic acids, partial hydrolysis products of starch acrylonitrile copolymers and starch acrylic acid graft copolymers [3]. In this research, coir dust acrylic acid grafted super absorbent polymer was used for testing material. There are many advantages in using super water absorbent polymers, they are; control of soil erosion and water runoff, increasing infiltration capacity, increasing soil aggregate size, reducing soil bulk density, increasing water retention , improving the survival of seedlings subjected to drought, lengthening shelf-life of pot plants, improving nutrient uptake by plants grown in poor soil, minimizing nutrient losses through leaching under highly leached conditions and reducing irrigation frequency [6]. Concerning that most central areas of our country are located in arid and semiarid regions, efficient use of water is essential. Implementing proper management practices in order to maintain soil moisture and increase water retention capacity is considered as one of the ways to save water. At present urban people all over the world are interested in practicing crop cultivation as a hobby and as a way to generate an income to support the economy of the family. One of the major problems faced by the urban agriculturists in our country is difficulty in finding good quality soils. Daily watering has also become a concern due to their busy life and costly water bill. SPAs are becoming as commonly applied in soil cultivations to overcome the water scarcity [1]. The present study focused to evaluate the effects of SAPs on growth of eggplant at the same media prepared by adding 3days a time watering intervals and soil media incorporated with the best weight of super absorbent polymer (SAP).

2. Literature Review

2.1 Super Absorbent Polymers

Super Absorbent Polymers (SAPs) are structurally cross-linked, highly swollen and hydrophilic polymer networks capable of absorbing a large amount of water or aqueous saline solutions in relatively short periods. SAPs are not dissolved in the media due to their three-dimensional structure [1]. The water absorbency of a SAP is greatly influenced by its composition, molecular weight, degree of cross linking, the molecular conformation of the polymer, and by properties of liquids to be absorbed (Chen and Tan, 2006). SAPs are commonly based on acrylic monomers such as acrylamide, acrylic acid and salts of the acid (Omidianet al., 1998). Commercially, SAPs are majorly produced with acrylic acid as a key component (Lanthong et al., 2006). The super-swelling characteristics of SAPs equipped them for use in water absorbing applications such as personal hygiene products, disposable diapers, bag flood protection, absorb toxic heavy metal ions, organic waste collector, cosmetic and special in agricultural use as stabilizer for soil moisture [4].

2.2 Applications of the Super Absorbent Polymer in Agricultural Field

In agriculture super absorbents use as soil additives to increase the water retention of soils, which can replace peat. Generally, SAPs are applied to the soil at a concentration between o.1 to 0.5% by weight (Buchholz and Graham 1998). Below this range, the effect of soil additive is negligible and above this range the soil can become too spongy when it is fully saturated. When polymers are incorporated with soil, it is presumed that they retain large quantities of water and nutrients. These stored water and nutrients release as required by the plants. Thus, plant growth could be improved with limited water supply. The uses of hydrophilic polymers in soils to improve both the nutritional and water status of plants have attracted considerable interest recently. When used correctly, SAP have the potentials to improved soil physical properties, reducing soil erosion and

nutrient loss, and improving runoff water quality, increasing seedling survival and reducing the irrigation requirement for plants. The SAP also prolonged water availability for plant use when irrigation stopped. The SAP usually has some effect on plant establishment with the greatest benefit for moisture loving plants planted under dryer condition. The use of hydrophilic polymer materials as carrier and regulator of nutrient release has shown promise for reducing undesired fertilizer losses, while sustaining vigorous plant growth.

2.3 Coir Dust Acrylic Acid (CDA) Super Absorbent Polymer

Super absorbent polymer for application as soil conditioner was prepared by radiation grafting and cross-linking of coir dust with different concentration of acrylic acid (30, 40, and 50%) in potassium hydroxide solution using gamma radiation with dose ranging from 10 to 30kGy. CDA super absorbent polymer is made up from environmentally friendly and naturally born polymers, which may regenerate or degenerate in the soil.

3. Methodologies

The pot tests of eggplants in prepared soils were studied out at the Department of nuclear engineering in Mandalay Technological University (MTU).

3.1 Sowing the seeds

Eggplant seeds were sowed onto the prepared ground and watering daily until seedling.

Figure 1: Seedling process

3.2 Preparing soil media

The soil samples were collected from near the department region at MTU. Each pot was supplied with 1500g collected soil. Sixteen pot soil media were prepared as showed in figure 2.

Figure 2: Preparing soil process

3.3 Method and experimental design

Fifteen kinds of CDA absorbent polymer samples (3g per 1.5kg of growth soil media) as shown in Table (1) were added to each pot and the same watering intervals (three days a time) were applied in this experiment.

Table 1: Types of CDA super absorbent polymer (SAPs) samples

Type of sample	Radiation dose (kGy)	Coir Dust (CD) g	Acrylic acid (%)	Apply of product sample(g)
F_1	10	6	30	3
F_2	15	6	30	3
F_3	20	6	30	3
F_4	25	6	30	3
F_5	30	6	30	3
F_6	10	6	40	3
F_7	15	6	40	3
F_8	20	6	40	3
F_9	25	6	40	3
F_{10}	30	6	40	3
F_{11}	10	6	50	3
F_{12}	15	6	50	3
$_{13}$	20	6	50	3
F_{14}	25	6	50	3
F_{15}	30	6	50	3
F_{16} (control)	-	-	-	-

One month after sowing, one seedling was transplanted in each pot and transplanting plants were watered daily for seven days until plants were well established. The amount of water, 1000ml, was used for plant growth. After seven days, some soils at the bottom of the plants were removed to add the sample. After that, 3g of SAPs were soaked in water for six hours and then filtered the swelling samples and added into the bottom of the plants. They were watered following the watering intervals (three days a time). After two months, the amount of plant watering was increased to 1500ml. Every three weeks, equal volume of foliar fertilizer was applied to each plant. During the period of flowering and fruiting fermented cattle manure solution were mixed respectively to the water used twice over the given period. Pests were controlled only when the infestation was seen to be a threat to normal plant growth. Some pesticides were used thrice over the given period too. Hand weeding was done when necessary. Weigh the fruits and recorded the amount of each plant. When the experiment was finished, all fruits were harvested and recorded and the amount of each. Weight of the harvested fruits per plant was record in grams (g).

Figure 3: The experiment of investigation on eggplant growth

4. Results

4.1 Investigation on Egg plant

In this study, plant growth and yield of eggplant was investigated to know the effect of super water absorbent on plant.

4.1.1 Investigation on Eggplant Growth

Figure 4 reveals eggplant growth (a) before, (b) after adding SAPs samples and (c) fruiting stage. According to the research experiment, before adding SAP it was found that the growth media was dry quickly than after adding SAP.

Figure 4: Growth Stage of Eggplant; (a) before adding SAP, (b) after adding SAP, (c) fruiting stage

Therefore, this research indicated that a polymer containing media causes increased water use efficiency and takes action by replacing common materials in the media. Similar conditions were obtained for the tomato plant, which indicates polymer effects on culture media (Islamic Azad University (AIU), Isfahan, Iran). In some situations, super absorbent polymers are used as releasing fertilizer agent of soil matrix, so that the polymer absorbs the nutrients needed by the plants and releases them gradually for the plants and thus prevent leaching of these elements. Table 2 describes investigation on eggplant growth. In table, plant height, stem diameter and yield per plant were illustrated. Plant height of acrylic acid monomer 30% and 40% with (10-30kGy) radiation doses were around 130cm and their stem diameters were around 1.5cm. At that time, SAP irradiated with 20kGy has 139cm in plant height and 1.8cm in stem diameter. However, there are quite different in plant height and stem diameter for control experiment both after one and three months. It was found that SAP irradiated with 20kGy has higher plant height and larger stem diameter than other SAP because it can control the moisture content of the soil for a long time.

Table 2: Experiment results in used of CDA super water absorbent polymer

Type of Sample	Plant Height (cm)			Stem Diameter (cm)	
	After one month	After two months	After three months	After one month	After three months
F_1	55	108	126	1	1.4
F_2	52	105	125	1	1.4
F_3	56	107	124	1	1.4
F_4	58	110	130	1	1.4
F_5	56	105	126	1	1.4
F_6	57	110	130	1	1.4
F_7	56	106	128	1	1.4
F_8	58	109	130	1.1	1.5
F_9	58	109	129	1.2	1.6
F_{10}	61	110	130	1.2	1.6
F_{11}	58	112	134	1.2	1.6
F_{12}	58	110	132	1.2	1.6
F_{13}	62	117	139	1.3	1.8
F_{14}	60	112	134	1.2	1.6
F_{15}	61	114	134	1.2	1.6
F_{16} (control)	52	106	124	0.8	1.3

4.1.2 Investigation on Eggplant Yield

Eggplant was grown with super water absorbent in the soil on (3-7-2016). After about two month, flowering process of eggplant started. In addition, the eggplant fruits began to produce in the plant after about two and half month. According to the data in table 3, it was found that 50% acrylic acid (F_{11} to F_{15}) SWAs samples have earlier flowery (4.8.2016) and the harvesting periods were obtained longer than the other acrylic acid percentage of SWAs. Data of measuring of fruit weight, the yield of eggplant with different radiation dose treatments was also shown in Table 3. The best producing weight was obtained from plant grown in soil with SWA irradiated with 20kGy. It was found that plant from the control treatment produced significantly less yield than all the other treatments. In addition, eggplant yield was found to increase with an increase in monomer concentration.

Table 3: Investigations on Flowery, Post Harvesting Date and Yield of Eggplant

Type of Sample	Acrylic Acid (%)	Radiation Dose (kGy)	Flowery Date	Post Harvesting Date	Yield/ Plant (g)
F_1	30	10	14.8.16	24.10.16	641
F_2	30	15	16.8.16	24.10.16	698
F_3	30	20	12.8.16	24.10.16	693
F_4	30	25	18.8.16	24.10.16	642
F_5	30	30	19.8.16	24.10.16	697
F_6	40	10	18.8.16	24.10.16	753
F_7	40	15	13.8.16	24.10.16	931
F_8	40	20	15.8.16	10.11.16	1031
F_9	40	25	13.8.16	10.11.16	1048
F_{10}	40	30	11.8.16	10.11.16	1117
F_{11}	50	10	8.8.16	27.11.16	1131
F_{12}	50	15	5.8.16	27.11.16	1252
F_{13}	50	20	4.8.16	27.11.16	1308
F_{14}	50	25	10.8.16	27.11.16	1161
F_{15}	50	30	8.8.16	27.11.16	1170
F_{16} (control)	-	-	18.8.16	24.10.16	602

5. Discussions

SAPs have been used in agricultural and horticultural fields due to their ability to retain water and nutrients when incorporated into the soil. The stored water and nutrients released slowly in required amounts to the plant rihzosphere, making them available to the plants under limited water supply conditions. The T.N. Fernando et al., (Open University of Sri Lanka) 2014; reported that using hydrophilic gels had positive and significant effect on number of flowers per plant, plant height, root proportion and coverage area in drought stress in daily and 1 day watering intervals using 0.3% of hydrogel. However, results of the present study indicated that not only suitable amount of SAP but also condition of soil media and watering intervals were affected that caused highest yield with highest plant height, percentage of acrylic acid (50%) with radiation dose 20kGy on 0.2% of hydrogel added to growth media and 3 days watered treatments compared to other treatments. Additional, plants showed blossom end rot diseases symptoms in less porosity in F_{13} sample. The reason could be the nutrient imbalance and physiological stress incurred due to water scarcity. Another reason for blossom end rot is lack of calcium in the fruits, by reducing cell membrane permeability leading to swelling of the cells followed by leakage and destruction of the membrane structure (Blossom-End Rot of Tomato, Pepper, and Eggplant, HYG-3771-96, 2013). There is also a reduction in growth of new cells due to some pesticides. A similar problem can arise when fertilizer is added to dry soil closer by around the plants, because the concentrated nutrients in the soil water will restrict water uptake by the plant.

6. Conclusions

In this study, fifteen samples of CDA super water absorbent were used in soil media with 3 days watering intervals. Growth condition of 50% acrylic acid with 20kGy (F_{13}) may result in good eggplant yield without infestation of blossom end rod and other toxic diseases. According to the experimental results, it was found that (F_{13}) super water absorbent has been performed more than the others with high yield. This characteristic is capable of holding a large amount of water.

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References

[1] T.N. Fernando, A.G.B. Aruggoda, C.K. Disnayaka and S.Kulathunge. Evaluating the effects of different watering intervals and prepared soilless media incorporated with a best weight of super absorbent polymer (SAP) on growth of tomato. Volume 02, no.02, September 2014.

[2] Suda Kiatkamjornwong, “Superabsorbent Polymers and Superabsorbent Polymer Composites”, Department of Imaging and Printing Technology, Chulalongkorn University, Thailand, 2007.

[3] Buchholz , FL (Editor) & Graham, AT, “Modern Superabsorbent Polymer Technology”, USA, November, 1997.

[4] Yazdani F, Allahdadi I, Abas Akbari G. (2007): Impact of superabsorbent polymer on Yield and Growth Analysis of Soybean (Glycine max L.) under drought stress condition, Pakistan J. Bio. Sci., 10(23): 4190-4196

[5] Okorie F.C. (2003): Studies on Drought in the Sub-Saharan Region of Nigeria using Satellite Remote Sensing and Precipitation Data; Department of Geography, of Lagos, Nigeria

[6] Ahmed A. (1990): Applications of Functionalized polymers in agriculture; J. of Islam. Acad. Sci., 3(1): 49-61

[7] Sun G., Wheatley W.B. and Worley S.D. (1994): A new cyclic N-Halamine. Biocidal polymer; Indian Eng. Chem. Res., 33: 68-170

[8] Akelah A. and Rehab A. (1986): polymer molluscicides; J. Polym. Mater., 3: 83-85

[9] Hedrick R.M. and Mowry D.T. (1952): Effect of synthetic polyelectrolytes on aggregation, aeration and water relationships of soil. Soil Science, 73: 427-441

[10] Mohammad J. Zohuriaan-Mehr and Kourosh Kabiri (2008): Superabsorbent Polymer Materials: A Review; Iranian Polym. J., 17(6): 451-477.

[11] F.L. Buchholz and A.T. Graham (1997): "Modern Superabsorbent Polymer Technology", Wiley, New York.

[12] Lentz, R.D. (2003): Inhibiting water infiltration with PAM and surfactants: Applications for irrigated agriculture. J. Soil Water Conserv., 58: 290-300.

Author Profile

Min Naing obtained Master’s Degree in Nuclear Technology from MTU in 2009. His area of research is radiation processing of polymer, synthesis, characterization and application of graft copolymers of acrylic acid monomer onto coir dust.